"Some Dielectric Properties of Solid Glycerine." By Ernest Wilson, Professor of Electrical Engineering, King's College, London. Communicated by Sir William Preece, K.C.B., F.R.S. Received January 7,—Read January 22, 1903.

At high frequency, obtained by resonance, Thwing gives 56·2 for the specific inductive capacity of glycerine at 15° C.* The specific inductive capacity of pure liquid glycerine at 8° C. was found to be about 60, whether the frequency of experiment was of the order 2 million or 100.† At a frequency of 120 the specific capacity of glycerine varies from about 60 to 4·6, as the temperature is varied from $-50°$ to $-100°$ in platinum degrees.‡ The present paper deals with the specific capacity of glycerine at temperatures varying from about $+10°$ to $-80°$ C. The methods of experiment and the apparatus are those described in connection with the earlier experiments.† The platinum plates forming the electrodes of a condenser were placed in pure glycerine, supplied by Messrs. Hopkins and Williams, and after a preliminary experiment, made to find its conductivity (see table), the glycerine was frozen by aid of carbonic acid snow. The temperature of the glycerine was observed by aid of a platinum thermometer. At $-48°$ C. the specific capacity at about 2 million periods per second is 3·97. At $-44°$ C. the specific capacity at about 100 periods per second is 54, which is of the same order of magnitude as that given by Fleming and Dewar. The conductivity of this condenser at $-59°$ C., and with times of contact varying from 0·00002 to 0·009 second, was found and is shown by the curve No. 1 in the accompanying figure. If K be the instantaneous capacity and C the electric resistance, then the total capacity of the condenser at time t is

$$K + \int_0^t \frac{1}{C}\,dt - \frac{1}{C_\infty}t.$$

Now the capacity of this condenser at $-48°$ C. at about 2 million periods per second is 0·00032 micro-farad, and the value of $\int_{0\cdot00002}^{0\cdot009} \frac{1}{C}\,dt - \frac{1}{C_\infty}t$, as given by the curve, will only account for 0·00018 micro-farad. Assuming that it will be the residual charge which comes out in one-sixth of the period which produces the effect on the capacity, a large proportion of the residual charge comes out between the times $\frac{1}{12} \times 10^{-6}$ and 20×10^{-6} second. If the refractive index of the glycerine when frozen is taken to be 1·47 for short times, then Maxwell's law would indicate a specific capacity of 2·17; and

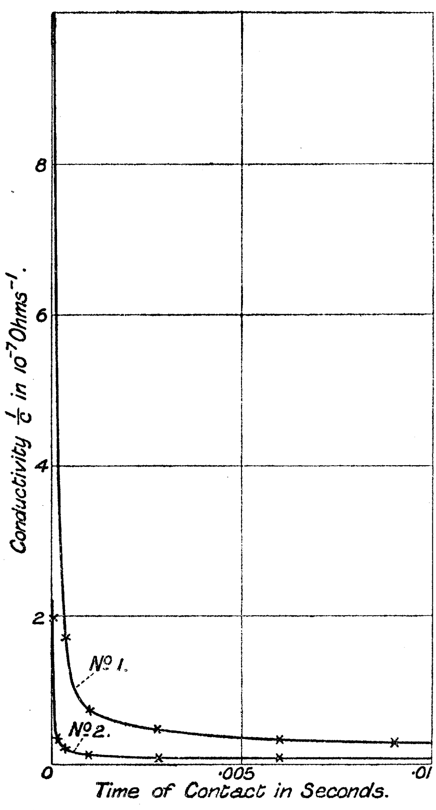
* 'Zeitschrift für Physikalische Chemie,' vol. 14, p. 293.

† Hopkinson and Wilson, 'Phil. Trans.,' A, vol. 189 (1897), pp. 109—136.

‡ Fleming and Dewar, 'Proc. Roy. Soc.,' vol. 61, p. 316.

3·97 was observed at 2 million periods per second. It is possible, therefore, that some residual charge has already come out at 2 million periods per second.

When the glycerine was warmed up to atmospheric temperature 10° C., it still remained *solid*, and its dielectric properties were examined at this temperature. The resistance of the condenser was 216000 ohms, whether the time of contact was 0·00002 or 0·011 second, and this is about $3\frac{1}{4}$ times the resistance at 10° C. when the glycerine was in the *liquid* state. No residual charge comes out between the above times. At 2 million periods per second the specific capacity of this solid glycerine at 10° C. is 6·67. By the method described previously* the specific capacity is 16 at 50 periods per second. The specific capacity in the liquid and solid states at 10° C. varies approximately as the conductivity for long times. The residual charge comes out at times less than 0·00002 second, whether the glycerine be liquid or solid at 10° C.



Finally, the condenser was frozen in carbonic acid snow in ether, and the conductivity at − 81° C. is shown by the curve No. 2 in the figure. The final conductivity is less, and the area is less than given by the curve No. 1. This difference is due to the lower temperature for curve No. 2. Fleming and Dewar have shown that the specific capacity of glycerine for long times changes very rapidly with its temperature between − 50° and − 100° Pt. The specific capacity at −81° C. was found to be 3·8 at 2 million periods per second.

During the freezing processes above referred to the conductivity of the glycerine was observed at different temperatures. The results are given in the accompanying table. It is noteworthy that for time 0·00002 second

* Hopkinson and Wilson, 'Phil. Trans.,' A, vol. 189 (1897), p. 118.

the conductivity falls and then rises, as the temperature is varied from +13° to −59° C. when freezing from the liquid to the solid state. An analogous effect has been observed in soda-lime glass.*

When the time of contact is 0·006 second, all the points in the table lie well on the same curve between −26° and −81° C. It is when freezing from the liquid to the solid states that such serious changes occur at the short times.

Time of contact in seconds after application of force.	Conductivity in 10^{-6} ohms^{-1}.						
	Freezing from liquid to solid state.			Freezing from solid state.			
	+13° C.	−26° C.	−59° C.	+12° C.	−48° C.	−75° C.	−81° C.
0·00002	15	1·72	8·03	4·63	0·388	0·191	0·197
0·00017	..	..	..	..	..	..	0·0301
0·00035	..	..	0·172	..	..	..	0·0201
0·00099	..	..	0·0708	..	..	..	0·0120
0·0028	..	..	0·0481	..	..	..	0·0109
0·0060	..	..	0·0319	..	0·134	0·012	0·00926
0·0090	15	0·67	0·0287	..			
0·011	..	..	0·0249	4·63			
0·018	..	..	0·0160				
			Curve No. 1				Curve No. 2

* Hopkinson and Wilson, 'Phil. Trans.,' A, vol. 189 (1897), pp. 109—136.